PREDICTION OF FE^{2+} CONCENTRATIONS USING LABORATORY RATE LAW IN WETLANDS CONSTRUCTED FOR ACID MINE DRAINAGE TREATMENT[1]

by

C. S. Kirby, H. M. Thomas, G. Southam and R. Donald[2]

Abstract. Laboratory rate laws for abiotic and biological Fe^{2+} oxidation were combined into a model to predict Fe^{2+} concentrations in ponds constructed for mine drainage treatment. Field measurements were made in twenty-two ponds seven passive treatment facilities with $2.8 < pH < 6.8$ and 7.5 mg/L <influence Fe^{2+} <240 mg/L. Model inputs include initial Fe^{2+} concentration, pH, dissolved oxygen (DO) and estimated *T. ferrooxidans* concentrations, temperature (T), pond volume, and flow rate. Predicted Fe^{2+} concentrations are within approximately 10% of measured Fe^{2+} except where seeps enter the treatment systems. Using only an abiotic rate law, the model accounts for Fe^{2+} concentrations in facilities which have pH>5.5. Combining abiotic and biological (*T. ferrooxidans*) rate laws allows prediction of Fe^{2+} concentrations in ponds with 3 < pH< 3.5. Where 5.5 < pH<6.5, increasing Fe^{2+} oxidation rates (decreasing Fe^{2+} concentrations in ponds) occur due to increasing parameters in the following order of effectiveness: pH≈T> pond volume ≈initial Fe^{2+} concentration > DO. These results suggest that treatment facilities may be undersized unless pH and Fe^{2+} oxidation are considered. Measured *T. ferrooxidans* concentrations are four to six orders of magnitude lower than concentrations required in the model to reproduce measure Fe^{2+} concentrations, which suggests that either the measured bacteria concentrations from this study are too low, the biological rate law attributes too little catalytic effect to each bacterial cell, or both. Results also suggest that *T. ferrooxidans* survive circumneutral pH values or at least repopulate ponds where pH drops due to insufficient alkalinity.

---

[1]Paper presented at the 1998 Annual Meeting of the American Society for Surface Mining and Reclamation, St. Louis, Missouri, May 16-21, 1998.

[2]Carl S. Kirby and Heather M. Thomas are Assistant Professor of Geology and undergraduate student, respectively, Bucknell University, Lewisburg, PA 17837. Gordon Southam and Ravin Donald are Assistant Professor of Biology and graduate student, respectively, Northern Arizona University, Flagstaff, AZ 86011-5640.